

REMARKS

The Examiner's Action mailed on August 5, 2008, has been received and its contents carefully considered. It is respectfully submitted that the final rejections herein be reconsidered, and the Amendment should be entered under 37 CFR §1.116 (b)(2) as presenting the application in better form for consideration on appeal.

In this Amendment, Applicants have amended claim 1. Claim 1 is the only independent claim pending and under consideration, and claims 1-4 remain pending and under consideration in the application, claims 5-7 having been withdrawn from consideration. For at least the following reasons, it is submitted that this application is in condition for allowance.

In the present invention an electric current blocking portion is formed on an exposed surface of the p-type layer of the semiconductor lamination portion exposed by removing a part of the light transmitting conductive layer for preventing current from flowing into the lower side of the upper electrode as much as possible since light emitted upon flow of current to the lower side of the upper electrode cannot be effectively extracted, and in that the upper electrode is formed on the electric current blocking portion, so as to adhere to the semiconductor lamination portion and to be in contact with the light transmitting conductive layer on a periphery of the part removed.

Claim 1 presently recites "an upper electrode formed so as to be in contact with an exposed surface of the p-type layer of the semiconductor lamination portion exposed by removing a part of the light transmitting conductive layer, and to be in contact with the light transmitting conductive layer on a periphery of the part removed; and *an electric current blocking portion formed on the exposed surface of the semiconductor lamination portion*, the electric current blocking portion preventing electric current from flowing into a part of the semiconductor lamination portion under the upper electrode through the electric current blocking portion".

In the Response to Arguments, the Examiner alleges that an "electric current blocking section" is taught by removed portions of light transmitting conductive layers **60** in *Kunisato et al.* (US 5,990,496) and **44** in *Chang et al.* (US 6,583,443 B1) respectively. The *Kunisato et al.* and *Chang et al.* references will be discussed with respect to each rejection as appropriate.

Claims 1-2 and 4 were rejected under 35 USC §102(b) as anticipated by, or alternatively under 35 USC §103(a) as obvious solely over, *Kunisato et al.* (US 5,990,496). These rejections are each respectfully traversed.

The Office Action asserts that the layer **60** of *Kunisato et al.* is a light transmitting conductive layer. However, this layer **60** is a *current blocking layer* of SiO₂, SiN, or n-type GaN, as described in column 11, lines 6 to 10 thereof:

An SiO₂, SiN, or n-type GaN current blocking layer 60 having a stripe-like opening in the center is formed on the p-type GaN contact layer 59. A p electrode 61 is formed on the p-type GaN contact layer 59 and an n electrode 62 is formed on the n-type GaN contact layer 54.

SiO₂ or SiN is an insulating layer and cannot be a conductive layer. By being disposed on a p-type GaN contact layer 59, the n-type GaN layer blocks electric current by forming a pn-junction of reversed direction with the p-electrode 9. To sum up, this layer is a layer that blocks the electric current from the p-electrode 9 to the p-type GaN contact layer 59 side, so that it is completely different from the *light transmitting conductive layer* of the present invention, which transmits the emitted light while diffusing the electric current from the p-side electrode 8 to the whole surface of the chip of the semiconductor laminate portion 6.

This is because the device of *Kunisato et al.* is not an LED that emits light from the whole surface of the chip but is a laser diode that emits light from only a part of the region having a stripe shape, and does not radiate light from the surface of the chip but radiates light from the end surface (side surface) of the chip, hence having a completely different function.

Consequently, *Kunisato et al.* fails to teach or suggest "an upper electrode formed so as to be in contact with an exposed surface of the p-type layer of the semiconductor lamination portion exposed by removing a part of the light transmitting conductive layer, and to be in contact with the light transmitting

conductive layer on a periphery of the part removed; and *an electric current blocking portion formed on the exposed surface of the semiconductor lamination portion*, the electric current blocking portion preventing electric current from flowing into a part of the semiconductor lamination portion under the upper electrode through the electric current blocking portion" as recited in claim 1.

Accordingly, claim 1 patentably defines over *Kunisato et al.* and is allowable, together with claims 2 and 4 that depend therefrom.

Claims 1-4 were rejected under 35 USC §103(a) as obvious over the combination of *Chang et al.* (US 6,583,443 B1) with *Shakuda et al.* (US 6,107,644). This rejection is respectfully traversed.

Chang et al. discloses an LED in which a transparent conductive layer **44** (n-type ohmic contact transparent electrode **35** of FIG. 3C, 3D and 3E) is formed on the etch stop layer **24** of the LED, and a metal layer **48B** is formed on a surface of the etch stop layer **24** that is exposed by removing a part of the transparent conductive layer **44**. However, this etch stop layer **24** is preferably InGaP or AlGaAs, and there is no disclosure of a gallium nitride based compound as in the present invention, so that it will not be a current blocking region even if it is exposed by removing a part of the transparent electrode. See column 4, lines 23 to 35:

The preferred material of the etching stop layer 24 according to the present invention can be any III-V compound semiconductor material that has an etching selectivity to that of the GaAs substrate 26. As to the lattice matched with that of the GaAs substrate 26 is not crucial. It's for sure, if the lattice matched well is also preferred because it can reduce the dislocation density. The good candidates of those satisfied above conditions, for examples, InGaP or AlGaAs can be served as the etch stop layer 24. The lower cladding layer 22 can also be served as the etching stop layer 24 since it has a high selectivity to GaAs substrate 26, and thus if the thickness of the lower cladding layer 22 is thick enough, the etch stop layer 24 becomes optional.

According to the present invention, an electric current blocking function is exhibited by a surface exposed by performing dry etching on the surface of a gallium nitride based compound.

Moreover, according to *Chang et al.*, the surface side is an n-type layer, and the etch stop layer 24 is also an n-type layer. This is clear from the fact that the GaAs substrate 26 and the lower cladding layer 22 are n-type layers. See column 3, lines 47 to 59:

Referring to FIG. 1, the cross-sectional view shows an epi-LED stack structure comprises, from a bottom thereof, an n-type temporary GaAs substrate 26, an etching stop layer 24, a lower cladding layer 22, an active layer 20 an upper cladding layer 18, a p-type ohmic contact epi-layer 16 and a p-type metal electrode 28. The shape of the metal electrode 28 is arbitrary, shown in the figure is a ring shape, so two electrode blocks 28 are observed in a cross-sectional view.

The lower cladding layer 22 is an n-type $(\text{Al}_{1-x})_{0.5}\text{In}_{0.5}\text{P}$. The active layer 20 is an undoped $(\text{Al}_{1-x})_{0.5}\text{In}_{0.5}\text{P}$ layer and the upper cladding layer 18 is a p-type $(\text{Al}_{1-x})_{0.5}\text{In}_{0.5}\text{P}$ layer.

Further, the contact characteristics of the metal layer **48B** with the n-type ohmic contact transparent electrode **35** (see column 5, lines 25 to 26: "Then, an n-type ohmic contact transparent electrode **35** is deposited on the etch stop layer **24** and on the third photoresist resist pattern **34**") and the etch stop layer **24** will have a similar tendency (when viewed from the metal layer **48B**, both are in contact with the n-type transparent conductive layer **44** and the semiconductor layer **24**).

However, according to a preferred embodiment of the present invention, the light transmitting conductive layer is made of an alloy of Au-Ni composition or a material generally exhibiting an n-type such as ZnO or ITO, and the surface of the semiconductor layer **5** that is brought into contact with the upper electrode **8** is a p-type, and the contact characteristics with the upper electrode are different from those of the transmitting conductive layer with the upper electrode, so that it can improve the ohmic contact characteristics between the upper electrode and the light transmitting conductive layer and can reduce the contact characteristics between the upper electrode and the exposed p-type semiconductor layer.

To sum up, contrasting the present invention and *Chang et al.*, the semiconductor layer that is brought into contact with the upper electrode is made of a different material and has a different electric conductivity even though having the same structure of providing a light transmitting conductive layer on the semiconductor layer, so that the two cannot have the same contact characteristics.

The Office Action alleges that, since *Shakuda et al.* discloses a semiconductor laminate portion made of a gallium nitride based compound semiconductor, it can be used to replace the semiconductor layers of *Chang et al.* However, the present invention uses the current blocking characteristics of the surface exposed by etching the surface of the gallium nitride based compound semiconductor layer. Therefore, as the LED of Chang does not exhibit such current blocking characteristics, there is no reason to apply to the LED of *Chang et al.* the semiconductor laminate portion made of a gallium nitride based compound semiconductor of *Shakuda et al.* that neither teaches nor suggests achieving the current blocking characteristics by etching the gallium nitride based compound semiconductor surface. The reason given in the Office Action, "to obtain a light emitting device with improved efficiency", is based upon impermissible hindsight, i.e. such a reason is based upon knowledge of the present invention.

Therefore neither *Chang et al.* nor *Shakuda et al.*, whether taken separately or in combination, teach or suggest "an upper electrode formed so as to be in contact with an exposed surface of the p-type layer of the semiconductor lamination portion exposed by removing a part of the light transmitting conductive layer, and to be in contact with the light transmitting conductive layer on a periphery of the part removed; and *an electric current blocking portion formed on the exposed surface of the semiconductor lamination portion*, the electric current blocking portion preventing electric current from flowing into a part of the

semiconductor lamination portion under the upper electrode through the electric current blocking portion” as recited in claim 1.

As to claim 3, semiconductor layer **51** in FIG. 6 of *Chang et al.* does not contain oxygen, and a dielectric layer is simply buried therein, so that the semiconductor layer surface does not contain oxygen. Also, high resistance region **61** in FIG. 7 is formed by ion implantation; however, ions are implanted to a certain depth by ion implantation, and this is different from a layer in which the exposed surface of the semiconductor layer contains oxygen. Inherently, these current blocking regions are formed on the etch stop layer **24**, the transparent electrode **56** or the transparent conductive layer **63** is formed thereon, and the metal bonding layer **57B** or **65B** is formed thereon, so that it is completely different from a semiconductor layer surface that is in direct contact with the upper electrode and contains oxygen.

Claim 3 therefore patentably distinguishes over the combination of *Chang et al.* and *Shakuda et al.* for at least this additional reason.

Consequently, claims 1-4 are allowable over *Chang et al.* and *Shakuda et al.*

It is submitted that this application is in condition for allowance. Such action and the passing of this case to issue are requested.

Should the Examiner feel that a conference would help to expedite the prosecution of this application, the Examiner is hereby invited to contact the undersigned counsel to arrange for such an interview.

Should the remittance be accidentally missing or insufficient, the Commissioner is hereby authorized to charge the fee to our Deposit Account No. 18-0002, and advise us accordingly.

Respectfully submitted,



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Date

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